PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATIONS IN THE VICINITY OF BCM TECHNOLOGIES LTE., AMHERSTBURG 1986 AND 1987

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PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATIONS IN THE VICINITY OF BCM TECHNOLOGIES LTD., AMHERSTBURG

1986 and 1987

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Introduction

The BCM Technologies Ltd. plant in Amherstburg is a relatively new chemical facility whose sole product is sodium chlorate. This chemical is manufactured by creating a concentrated acidic solution of sodium chloride which is heated and then electrolyzed. During the electrolyzation process, sodium chlorate is crystallized out, hydrogen gas is produced and vented and a solution containing a mixture of oxidation products (sodium hypochlorite, sodium chlorite, sodium perchlorate and some sodium chlorate) remain in the cell.

Sodium chlorate is an oxidizing agent and is commonly utilized as a bleach for paper pulps and in the processing of ore. It is also a herbicide and defoliant.

Shortly after the BCM Technologies plant became operational in early 1980's, the Phytotoxicology Section received a complaint of vegetation injury from a private citizen whose property was located immediately north of the new plant.

During the investigation of the complaint, Phytotoxicology investigators observed and documented the presence of severe foliar injury on the property. Several large honey locust trees at the front of the property were found to be severely defoliated or dead. Investigators examined the immediate area around the complainant's property and found that visible injury symptoms were generally restricted to the area north of the plant and completely disappeared about 100 metres from the source. According to the complainant, the locust trees were healthy prior to the arrival of the plant and no vegetation injury with the observed symptomatology was present. In 1986, the complainant's property was sold to BCM.

In 1985, a complaint of injury to field corn on a property located immediately southwest of BCM, was received by the Ministry. Injury symptomatology was found to be similar to that found in the earlier complaint. Chemical analysis results of sampled corn foliage and soils from the field indicated the presence of elevated sodium and chloride values in the materials. Based on the chemical analysis results and similarity of injury to that observed earlier, the investigation report (ARB-216-85-Phyto) concluded that the injuries were caused by emissions from the BCM plant.

Since the plant started production, a number of nearby residents have lodged complaints with the Ministry about offensive chlorine odours in the air. In the spring of 1986, Mr. John Luyt of the Ministry's Windsor office attended a public meeting called by the company to hear complaints from concerned citizens. Because of the number of complaints received by Mr. Luyt regarding vegetation injury and chlorine odours, the Windsor office placed a request with the Phytotoxicology Section for an investigation of the complaints and a study to determine the extent of the area affected by emissions from BCM.

On May 28 and 29, 1986 Phytotoxicology Section representatives visited the Amherstburg area and contacted each of the 3 complainants who had spoken with Mr. Luyt at the meeting about injury to vegetation on their properties. Generally, the complainants advised that vegetation injury symptoms were present during the summer of 1985, but that no problems were present on the 1986 foliage. All were advised to contact the Ministry in the event that injury occurs again in the future.

Phytotoxicology Surveillance of BCM

In May of 1986 Phytotoxicology representatives visited the area around BCM Technologies Ltd. and initiated a surveillance program to monitor emission effects in the vicinity of the plant. The program was designed to meet the following objectives: (1) provide data relating to the documentation of vegetation injury symptomatology, the extent of the vegetation injury area and the determination of chemical element levels in sampled foliage, and (2) attempt to more accurately delineate the area influenced by BCM-related emissions by means of a passive moss bag monitoring network.

The surveillance of vegetation around the BCM plant was continued in 1987 at 9 of the 10 sites established in 1986 (Figure 1). As the figure demonstrates, the survey sites provide coverage around the entire plant but are skewed to the north and northeast directions to reflect the prevailing south and southwesterly summer winds.

The property immediately west of BCM is owned by General Chemical and is surrounded by a high wire fence. Consequently the establishment of survey sites in that direction was not possible.

Silver maple trees initially selected for observational and collection purposes in 1986 at 9 of the 10 sites were utilized again in 1987. The species was not available at site 61. On two occasions during the summer, the silver maple foliage at each of the 9 sites was examined for evidence of air pollution injury and then sampled in triplicate for chemical analysis from the side of the tree facing BCM.

The first 1987 surveillance visit took place on May 27, the second on August 31. In both years, samples were collected in clean, new plastic bags and returned to the Phytotoxicology laboratory in Toronto to be processed as not-washed according to a standardized method. Completed samples were forwarded to the Ministry's Inorganic Trace Contaminants laboratory for the determination of sodium, chloride and fluoride values. Although fluoride emissions were not suspected from the BCM plant, they were included because of the proximity of the Allied Chemical plant which manufactures hydrofluoric acid (located next to General Chemical) and because of the possibility of utilizing the fluoride data as a tracer for sodium and chloride emissions from the General Chemical plant.

Air Monitoring Surveillance

Moss bags have been used for a number of years to monitor atmospheric emissions of heavy metals and other elements from a variety of sources. Although the data produced are not quantitatively as accurate as air quality instrumentation and cannot be equated to specific air quality values, they can provide valuable reference data regarding deposition of emitted contaminants.

With regard to salts, moss bags have been used successfully to monitor sodium and chloride under winter conditions. In the summer, however, chlorides are easily removed from the moss fibres by rain. Consequently, analytical results of exposed bags may not be a true reflection of total chlorides which were adsorbed by the moss. For this reason, data generated by this method remains in the evaluation stage. Sodium, however, seems to bond much more securely to the moss and is less likely to be removed by wet conditions.

Bags used by the Phytotoxicology Section consist of laboratory-washed and selected Sphagnum moss fibres. Three grams (± 0.1 grams) of processed mosses are contained within a bag of polypropylene screening (mesh size 1.5 x 2.0 mm) measuring approximately 15.5 x 6.5 cm, providing a surface area of 100cm^2.

Since moss bags are usually affixed to utility poles, trees or other structures, the bags are always utilized in conjunction with a specialized moss bag holder and support tube (Figure 2). Ideally, bags are attached to support holders approximately 3 metres from the ground.

The moss bag monitoring network around BCM was established and operated for a 5 month period (May 29 to October 28) during the summer of 1986 (Figure 1).

In 1987, the moss bag network was re-established on April 29 and all bags were exchanged monthly until the end of September. Bags collected at the end each of the five monthly exposure periods were placed in plastic bags and returned to the Phytotoxicology laboratory for processing prior to submission for chemical analysis.

1986 and 1987 Vegetation Surveillance Results

Visual

In order to determine the size and configuration of the zone containing injured vegetation, a detailed survey was conducted in the immediate area around the BCM plant. On those aspects where injury was found, the examination of foliage was continued away from BCM to the point where injury symptoms were no longer visible.

The zone containing injured vegetation observed in 1987 is shown in Figure 3. The injury zone for 1986 was virtually identical in configuration, size and directional emphasis. In both years, the most severely injured vegetation was found immediately north of the BCM plant at site 60 (property of the former complainant). Beyond 100 metres north

of the plant, no evidence of injury symptoms were visible.

Southwest of BCM, injury was noted in 1986 and again in 1987 on wild grape and other wild foliage located on the General Chemical east-west fence line approximately 100 metres from the BCM plant. Virtually no injury was observed immediately east or south of BCM.

Although there was some variability of injury symptomatology, the most common form was terminal, marginal and intercostal necrotic spotting. On some species, however, injury appeared as terminal and intercostal necrosis.

At site 60, injury of both types was observed, although the spotting type was most common. On species such as hawthorn and silver maple, injury appeared mainly as dark brown terminal and marginal necrosis. Samples of injured vegetation exhibiting both forms of injury expression were collected for preservation in the Phytotoxicology herbarium. A wide variety of injured plants were photographed for documentation purposes.

It is important to note that the spotting-type injury symptomatology observed at site 60 and along the General Chemical fence-line southwest of BCM has never been observed at vegetation surveillance sites associated with the Phytotoxicology surveillance of Allied/General Chemical. The fact that the spotting-type injury was most severe near BCM and decreased very rapidly within a very short distance implicates BCM as the likely emission source for this type of foliar injury.

Chemical Analysis Results - Vegetation

Sodium

Sodium values found in the not-washed silver maple collected at 9 sites surrounding BCM in 1987 have been assembled in Table 1. Each value shown represents the mean of the triplicate sample results. At the base of the table, the Phytotoxicology guideline representing the upper limits of normal concentration of sodium found in rural not-washed foliage has been shown.

The sodium and other guidelines were determined from a large group of foliar samples collected from rural areas of Ontario not subject to the influence of point source emissions. The guidelines represent the mean of available analytical data plus three standard deviations of the mean. Ninety-nine percent of contaminant levels in samples obtained from areas not affected by point sources will lie below these 'upper limits of normal'. Concentrations which exceed the guidelines are indicative of pollution, be it from an identifiable source or not.

In the May 1987 foliage, the guideline of 50 ppm was exceeded at 7 of the 8 sample sites (silver maple is not available at site 61). The highest values were found at sites 60 (387 ppm) and 66 (117 ppm). In the August 1987 collection, the sodium value at site 60 had decreased to 153 ppm. At site 66, the value had decreased marginally to 112 ppm. The annual mean sodium values of the individual surveillance sites listed in

the table show that the highest concentration of the element was found at site 60. South-southwest of the BCM plant at site 66, the annual mean was 114 ppm. Immediately south of the plant at site 68, the annual mean was 93 ppm. All three sites are situated closest to BCM.

Sodium values found in the 1986 silver maple foliage appear in Table 2. The May foliage exceeded the Phytotoxicology guideline at 5 of 7 eligible sites, with the highest values occurring at sites 60 and 63. The next highest individual value was found at site 66.

The highest sodium value in the September foliage occurred at site 60 (147 ppm) followed by sites 68 (110 ppm), 66 (106 ppm) and 67 (92 ppm). The highest annual mean occurred at site 60.

Sodium Summary

The general trend of higher sodium values at the three sites (60, 66 and 68) closest to the BCM plant first observed in 1986, appeared to continue in 1987. Sodium values in silver maple foliage exceeded the Phytotoxicology rural guideline on twelve occasions in 1986 and 11 occasions in 1987.

In evaluating the possible influence of the BCM plant on the sodium values throughout the survey area, it is apparent that a very localized zone of contamination exists to the immediate north and southwest of the plant. However, it is also apparent that sodium emissions from the BCM plant are superimposed on a more widespread zone of contamination from the more distant General Chemical plant.

Chloride

Chloride values found in the 1987 not-washed silver maple foliage have been assembled in Table 3. Each value shown represents the mean of the triplicate sample results. The Phytotoxicology upper limit of normal guideline of 0.15% for chloride in not-washed rural foliage appears in the table for reference purposes. The guideline was exceeded at two sites in the May foliage with the highest value occurring at site 66 (0.21%). The August foliage exceeded the guideline on four occasions - the highest occurring again at site 66 with 0.51%. Mean chloride values at the control site exceeded the guideline in both the May and August collections. The highest annual mean chloride value in 1987 (May and September foliage collections) was found at site 66.

Annual mean values for the 1986 maple foliage reveal a similar pattern as observed in 1987 (Table 4). Foliage at 2 sites, plus the control site, in the May collection exceeded the guideline. In September, 4 sites and the control site had values above the guideline. The highest annual chloride value in the 1986 foliage occurred at site 66.

Chloride Summary

Chloride values in silver maple foliage at several sites close to the BCM plant exceeded the Phytotoxicology guideline in 1986 and 1987. Values which exceeded the guideline at several more distant sites (63 and 64) may be a reflection of the influence from the General Chemical complex. The excessive chloride values found in the control site (65) foliage can only be attributed to de-icing salts applied to the nearby road in the winter.

Fluoride

Fluoride values found in the 1987 and 1986 maple foliage appear in Tables 5 and 6, respectively. Analysis for this element was requested in order to track the influence of possible salt emissions from the nearby General Chemical complex. Each value shown in the table represents the mean of the triplicate sample results.

In 1987, fluoride values in the May foliage exceeded the Phytotoxicology guideline at two sites (60 and 68) close to BCM and also at the control site (65). In August, the foliage exeeded the guideline at 3 sites and at the control location. The excessive values of the element at sites near BCM can be attributed to the influence of emissions from the General Chemical/Allied Chemical complex but the high values which were evident at the control site cannot be explained (Table 5).

In 1986, the May foliage exceeded the Phytotoxicology guideline at one site (67). In September, however, fluoride values escalated sharply and concentrations at all sites were above the guideline with the highest value (107 ppm) occurring at site 60 (Table 6).

Fluoride Summary

Fluoride values in excess of the Phytotoxicology guideline were found in maple foliage at all sites, including the control location, in the September, 1986 collection.

Three exceedences of the guideline occurred in the August, 1987 foliage plus at the control location. The elevated values of the element found at the study locations can be attributed to the influence of emissions from the Allied and General Chemical complex but the high values at the control site cannot be explained.

The pattern of elevated fluoride values in silver maple foliage at sampling sites throughout the vicinity of BCM in 1986 and 1987 confirms that emissions from the Allied and General Chemical facilities also have influenced the chemistry of vegetation near the BCM plant.

Chemical Analysis Results - Moss Bags

Sodium

Sodium values found in moss exposed for monthly periods from May until the end of October, 1987 have been assembled in Table 7. Although the monthly values at site 60 appear variable, this site had the highest annual mean value of all moss bag locations. Similarly, the highest annual mean of all sites in 1986 (570 ppm) was also found at site 60 (Table 8).

Chloride

Chloride values found in the 1987 moss bags have been assembled in Table 9. According to the Phytotoxicology upper limit of normal guideline for the element in rural moss bags, numerous exceedences occurred during 4 of the 5 monthly exposure periods. Only one exceedence (site 60) occurred during the July 28 - August 31 period. The highest annual mean (0.14%) was found at site 60.

Values of chloride found in the 1986 moss bags appear in Table 10. The number of sites with values which exceeded the Phytotoxicology guideline was considerably lower than in 1987. The highest 1986 annual mean (0.10%) occurred at site 60.

The widespread occurrence of chloride values above the Phytotoxicology guideline at most most 1987 moss bags sites would again suggest that emissions of the element from the BCM plant are superimposed on a more widespread zone of contamination from the General Chemical/Allied complex.

Fluoride

Fluoride values found in the 1987 moss bags appear in Table 11. Values in excess of the guideline occurred at a greater number of sites during the first exposure period (April 29 - May 27) than during any of the remaining four periods. The large number of sites with excessive values indicates the widespread influence of emissions from the General Chemical/Allied complex. Sites 63 and 64 recorded the highest annual mean values.

In 1986, (Table 12) the pattern of sites with excessive fluoride values in moss bags demonstrates the influence of General Chemical/Allied emissions on the entire area. The highest mean fluoride value was found at site 61.

Moss Bag Results - Summary

Although excessive values of sodium and chloride were found at many moss bag sites during individual exposure periods, the highest mean annual sodium and chloride values were found at site 60, close to the BCM plant. This evidence would associate the bulk of the high values

with sodium and chloride emissions from the BCM plant. However, the presence of excessive fluoride values throughout the survey area including sites near the BCM plant, confirms the general influence of emissions from the General and Allied Chemical complex on the BCM survey area.

Phytotoxicology Greenhouse Experiments

1986

Although emissions from BCM in 1985 were believed to be responsible for the vegetation injury on the property of the former complainant (site 60) and to the corn southwest of the plant, the injury-causing agent or agents could not be positively identified. Histological examination results of the injured vegetation material were only able to indicate that a topical application of an unknown chemical had 'burned' the epidermal cells of the upper leaf surfaces.

Based on the nature of operations at the BCM plant, liquid chlorine aerosol emissions (from the stack) and sodium chlorate particles (from the bulk loading process) were the two most likely causal agents. In an effort to identify the injury-causing chemical agent, tests using these two materials were conducted at the Phytotoxicology laboratory in Brampton in 1986-87.

Samples of sodium chlorate crystals and liquid from the electrolization cell were obtained from BCM officials for experimentation purposes. Individual crystals of sodium chlorate were applied to cucumber, beet, tobacco and Manitoba maple foliage in the greenhouse. Cell liquid was applied in the form of a fine mist to other plants of the same species.

In less than 24 hours, the application of sodium chlorate crystals produced total necrosis of the treated foliage. In the case of tobacco, the treatment eventually caused the entire plant to die. None of the injury symptoms appeared similar to the intercostal spotting or marginal necrosis observed in the field.

Injury obtained from the application of the cell liquid also became visually apparent in less than 24 hours. Injury symptoms were both in the form of intercostal necrotic spots and marginal necrosis.

Although controlled environment experiments can never duplicate exact conditions in the field, the injury symptoms obtained from the application of the cell liquid were found to be very similar to those found on vegetation close to BCM at site 60.

Based on the 1986-87 greenhouse experiments, it appeared that emissions associated with the electrolization process induced the injury symptoms observed in the field.

1987

Further experiments were conducted at the Brampton laboratory during the summer of 1987 in an effort to duplicate the spotting-injury observed on plants at site 60.

Three separate treatments were applied to wild grape and Manitoba maple growing outdoors on the laboratory site. Both species were found on the former complainant's property and both displayed the spotting-type injury symptoms. Sodium chlorate was applied in crystal form and as a 10% solution. Liquid obtained from the BCM electrolization cell was also applied as a very fine spray.

The 1987 outdoor experiments generally confirmed the observations reached by the 1986 indoor tests. It was, however, found that the sodium chlorate in solution also produced the spotting injury, and that symptomatology was virtually identical to that induced by the cell liquid.

Although experiments have shown that dry sodium chlorate crystals produce atypical injury symptoms, these crystals in solution appear to have some potential to cause spotting injury to vegetation. In the field, however, this situation does not normally exist. At best, dry crystals on foliage may be wetted by morning dew and some dissolution may occur. Greenhouse tests in 1986, however, showed that the addition of a drop of moisture to a crystal of sodium chlorate on a leaf did not produce a spot of injury. Rather, a rather large necrotic patch of indiscriminate shape and size invariably resulted.

Even though there was a great deal of similarity of injury expression induced by both the cell liquid and the sodium chlorate crystals in solution, it is still concluded that components of the cell liquid, probably in the form of a fine aerosol, induced the spotting injury to foliage observed near the BCM plant.

Conclusions

Relatively severe foliar injury to a number of vegetation species, believed to be as a result of emissions from BCM Technologies, was found at site 60 (immediately north of the plant) and along a fence line southwest of the plant. At both locations, the injury symptomatology was peculiar to BCM and was confined to a relatively small area near the plant. Prior to the operations at BCM, no injury to vegetation at site 60 was observed by the former resident. After production started, extensive injury to vegetation and the eventual death of the honey locust trees at the site occurred. Similar symptoms or injury severity have never been observed near the General or Allied Chemical plants.

In both 1986 and 1987, analysis results of silver maple foliage clearly indicated that sodium values at the site (60) closest to the BCM plant were highest but declined at sites located farther away from the source.

Mean annual chloride values in maple foliage were greater at a

number of sites (including the control site) than at site 60 in 1986 and 1987. The higher values of the element at sites farther away from BCM, particularly at the control site, would suggest that the vegetation has accumulated chloride from another source such as de-icing salts.

Mean annual values in 1987 of the tracer element fluoride in maple foliage, was highest at the two sites (60 and 68) closest to BCM, except for the control location. The higher mean value at site 60 is no doubt a reflection of some emission-effect from General Chemical/Allied Chemical complex.

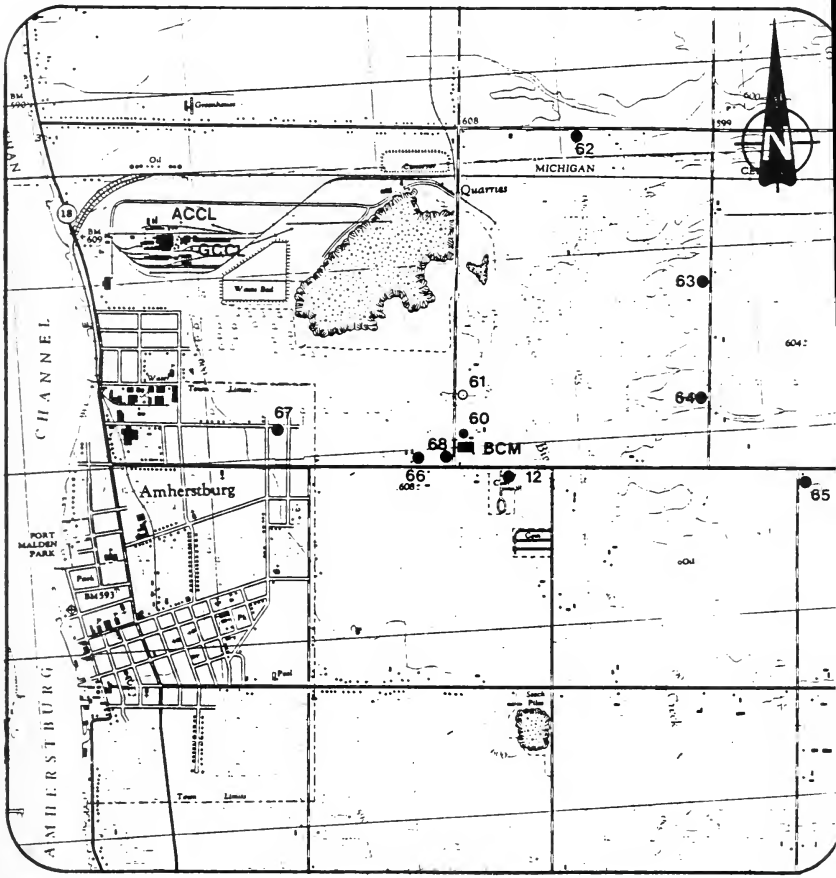
Mean annual sodium and chloride values found in moss bags in 1986 and 1987 were highest at site 60. Even though the chloride ion is highly leachable, the relatively elevated value of the element at site 60 is likely an indication that chlorides were constantly being replaced by ongoing BCM emissions. The elevated values of fluoride found on several occasions at site 60 confirms some general, low level emissions from the General and Allied Chemical plants.

Based on the collected visual and analytical evidence, it appears certain that sodium and chloride emissions from BCM have adversely affected vegetation in a relatively small area around the plant.

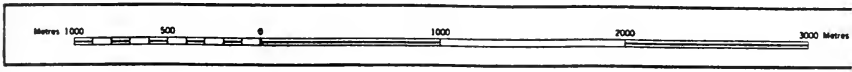
Results of greenhouse and outdoor experiments conducted by the Ministry, suggested that emissions, probably resulting from the electrolization process at BCM, induced the vegetation injury observed in the immediate vicinity of the plant

In December of 1987, BCM was purchased by CanadianOxy Industrial Chemicals Limited Partnership.

FIGURE: 1 Silver Maple and Moss Bag Surveillance Sites near BCM Technologies Ltd. 1987



SCALE



● – Moss bag and silver maple collection site

○ – Moss bag only

FIGURE: 2 Moss Bag, Holder and Mounting Tube

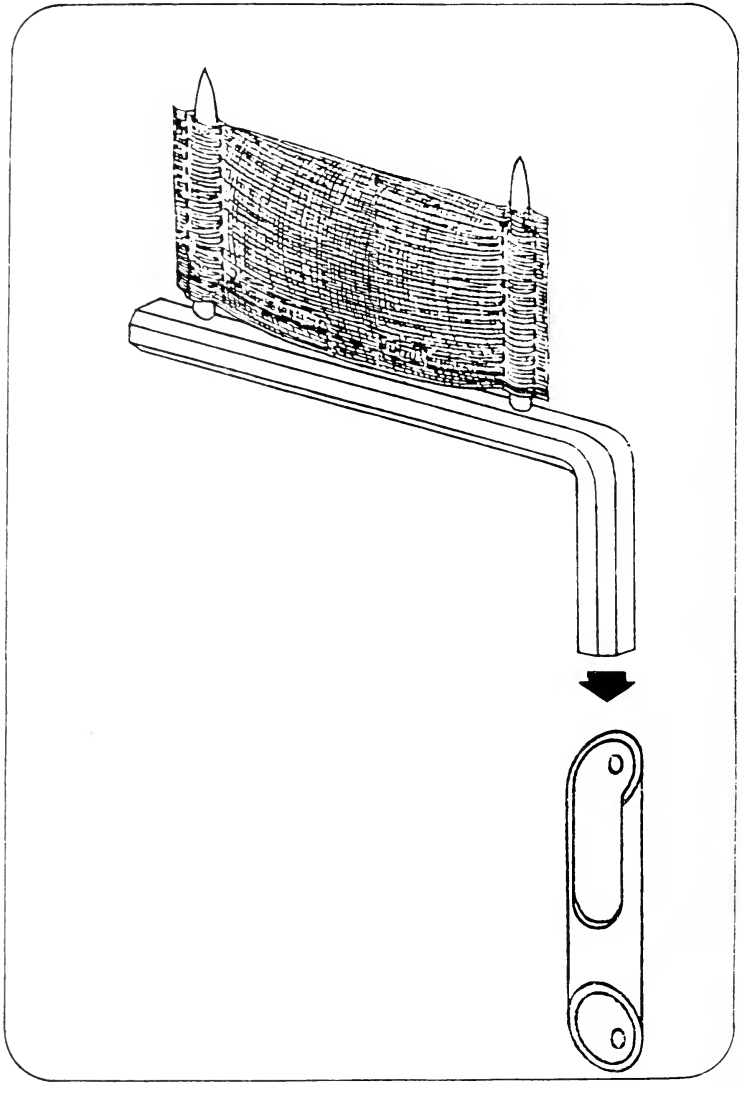
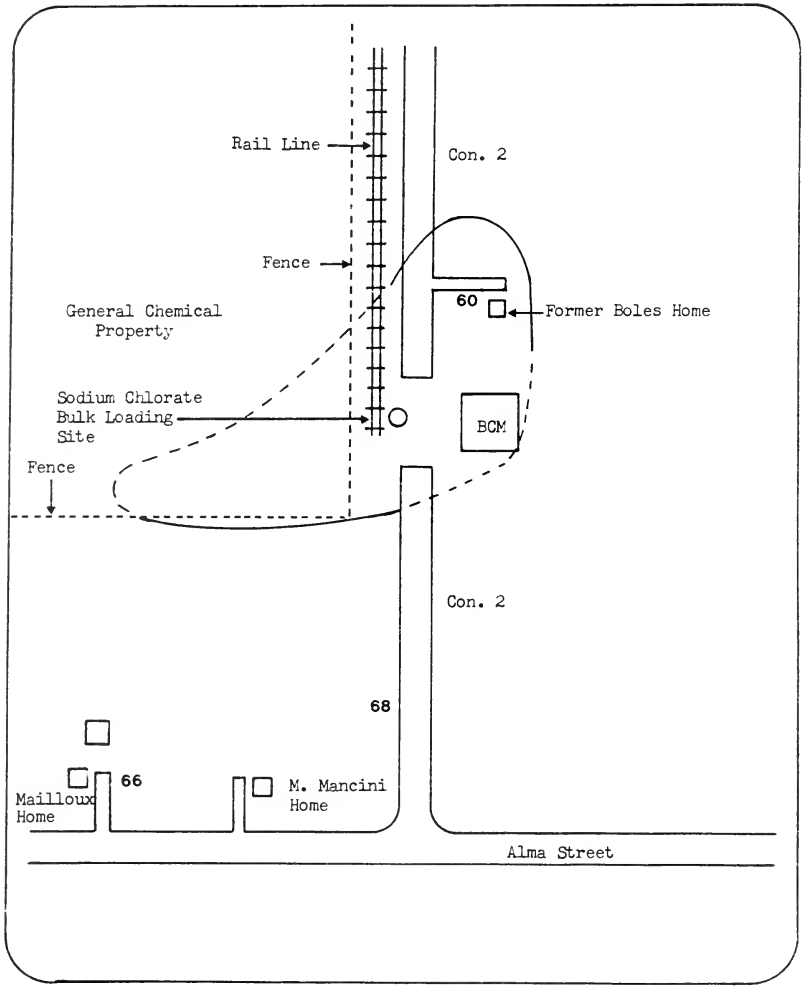


FIGURE: 3 Configuration and Relative Size of Vegetation Injury Zone in the Vicinity of BCM Technologies Ltd., Amherstburg 1986 and 1987



Sketch Not To Scale

- Confirmed vegetation injury zone

TABLE: 1 Sodium Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg

1987

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 27, 1987	August 31, 1987	
60	50 m N	387	153	270
61	300 m N	NA[2]	NA	–
62	1.8 km NNE	76	45	61
63	1.7 km NE	46	29	38
64	1.4 km ENE	57	66	62
12	300 m SE	72	45	59
66	250 m SW	117	112	114
67	1.0 km W	55	23	39
68	100 m S	86	99	93
65 (Control)	1.85 km E	38	36	37
Phytotoxicology Upper Limit of Normal Guideline for Not-Washed Rural Foliage		**50**	**50**	

[1] Expressed as parts per million (ppm) - dry weight

[2] Sample vegetation at this site not available

TABLE: 2 Sodium Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg

1986

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 28-29, 1986	Sept. 3, 1986	
60	50 m N	127	147	137
61	300 m N	NA[2]	NA	_
62	1.8 km NNE	47	32	40
63	1.7 km NE	110	84	97
64	1.4 km ENE	63	63	63
12	300 m SE	60	59	60
66	250 m SW	83	106	95
67	1.0 km W	33	92	63
68	100 m S	NE[3]	110	-
65 (Control)	1.85 km E	33	45	39
Phytotoxicology Upper Limit of Normal Guideline for Not-Washed Rural Foliage		**50**	**50**	

[1] Expressed as parts per million (ppm) - dry weight

[2] Sample vegetation at this site not available

[3] Survey site not established until September, 1986

TABLE: 3 Chloride Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg

1987

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 27, 1987	August 31, 1987	
60	50 m N	0.13	0.15	0.14
61	300 m N	NA[2]	NA	–
62	1.8 km NNE	0.07	0.10	0.09
63	1.7 km NE	0.09	0.17	0.13
64	1.4 km ENE	0.16	0.48	0.32
12	300 m SE	0.07	0.10	0.09
66	250 m SW	0.21	0.51	0.36
67	1.0 km W	0.09	0.09	0.09
68	100 m S	0.07	0.08	0.08
65 (Control)	1.85 km E	0.19	0.46	0.33
Phytotoxicology Upper Limit of Normal Guideline for Chloride in Rural Moss Bags		**0.15**	**0.15**	

[1] Expressed as percent (%) - dry weight

[2] Sample vegetation at this site not available

TABLE: 4 **Chloride Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg**

1986

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 28-29, 1986	Sept. 3, 1986	
60	50 m N	0.12	0.23	0.18
61	300 m N	NA[2]	NA	_
62	1.8 km NNE	0.06	0.11	0.09
63	1.7 km NE	0.14	0.26	0.20
64	1.4 km ENE	0.16	0.44	0.30
12	300 m SE	0.08	0.14	0.11
66	250 m SW	0.20	0.45	0.33
67	1.0 km W	0.07	0.11	0.09
68	100 m S	NE[3]	0.10	--
65 (Control)	1.85 km E	0.18	0.29	0.24
Phytotoxicology Upper Limit of Normal Guideline for Chloride in Rural Moss Bags		**0.15**	**0.15**	

[1] Expressed as percent (%) - dry weight

[2] Sample vegetation at this site not available

[3] Not established until September, 1986

TABLE: 5 Fluoride Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg

1987

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 27, 1987	August 31, 1987	
60	50 m N	17	23	20
61	300 m N	NA[2]	NA	-
62	1.8 km NNE	7	4	6
63	1.7 km NE	9	9	9
64	1.4 km ENE	12	9	11
12	300 m SE	12	9	11
66	250 m SW	13	14	14
67	1.0 km W	10	18	14
68	100 m S	19	21	20
65 (Control)	1.85 km E	33	45	39
Phytotoxicology Upper Limit of Normal Guideline for Not-Washed Rural Foliage		**15**	**15**	

[1] Expressed as parts per million (ppm) - dry weight

[2] Sample vegetation at this site not available

TABLE: 6 Fluoride Values[1] Found in Not-Washed Silver Maple Foliage Collected at the end of May and August in the Vicinity of BCM Technologies Limited, Amherstburg

1986

Silver Maple Collection Sites	Distance & Direction from BCM	Sample Dates		ANNUAL MEAN
		May 28-29, 1986	Sept. 3, 1986	
60	50 m N	7	107	57
61	300 m N	NA[2]	NA	-
62	1.8 km NNE	4	15	10
63	1.7 km NE	7	21	14
64	1.4 km ENE	6	18	12
12	300 m SE	6	26	16
66	250 m SW	5	51	29
67	1.0 km W	17	41	29
68	100 m S	NE[3]	56	-
65 (Control)	1.85 km E	4	20	12
Phytotoxicology Upper Limit of Normal Guideline for Not-Washed Rural Foliage		**15**	**15**	

[1] Expressed as parts per million (ppm) - dry weight

[2] Sample vegetation at this site not available

[3] Survey site not established until September, 1986

TABLE: 7 Sodium Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1987

Moss Bag Site	Exposure Period: April 29 -May 27	May 27 -June 24	June 29 -July 28	July 28 -Aug 31	Aug 31 -Sept 30	MEAN
60	1100	360	810	350	900	704
61	510	190	270	110	750	366
62	600	260	860	110	320	430
63	330	220	850	140	340	376
64	250	130	180	54	120	147
12	360	220	160	200	150	218
66	360	320	230	180	200	258
67	600	260	450	170	170	330
68	640	140	180	220	280	292
65 (Control)	250	130	130	110	110	146

[1]Parts per million (ppm) - dry weight

TABLE: 8 Sodium Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1986

Moss Bag Site	Exposure Period: May 29 -July 2	July 2 -July31	July 31 -Sept 3	Sept 3 -Oct 1	Oct 1 -Oct 28	MEAN
60	540	350	260	600	1100	570
61	1200	460	370	100	1400	454
62	690	290	140	490	430	408
63	970	480	620	310	250	526
64	600	150	56	120	85	202
12	NA[2]	343	140	130	150	191
66	370	260	130	73	120	191
67	600	300	220	140	170	286
68	NE[3]	NE	NE	NE	390	--
65 (Control)	250	94	75	94	110	125

[1] Parts per million (ppm) - dry weight

[2] Not available

[3] Moss bag not established until October 1, 1986

TABLE: 9 Chloride Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1987

Moss Bag Site	Exposure Period April 29 -May 27	May 27 -June 24	June 29 -July 28	July 28 -Aug 31	Aug 31 -Sept 30	MEAN
60	0.20	0.08	0.17	0.05	0.19	0.14
61	0.06	0.03	0.05	0.02	0.04	0.04
62	0.07	0.03	0.05	0.02	0.04	0.04
63	0.06	0.03	0.18	<0.01	0.03	0.06
64	0.05	0.03	0.04	<0.01	0.04	0.03
12	0.06	0.03	0.03	<0.01	0.04	0.03
66	0.07	0.04	0.03	0.02	0.03	0.04
67	0.10	0.04	0.03	<0.01	0.03	0.04
68	0.09	0.02	0.02	0.02	0.05	0.05
65 (Control)	0.05	0.03	0.02	<0.01	0.04	0.03

The Phytotoxicology Upper Limit of Normal Guideline for Chloride in Rural Moss Bags is 0.03%.

[1] Percent - dry weight

TABLE: 10 Chloride Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1986

Moss Bag Site	Exposure Period: May 29 -July 2	July 2 -July31	July 31 -Sept 3	Sept 3 -Oct 1	Oct 1 -Oct 28	MEAN
60	0.05	0.10	0.10	0.12	0.14	0.10
61	0.26	0.03	0.04	0.01	0.02	0.06
62	0.04	0.02	0.02	0.02	0.03	0.03
63	0.11	0.04	0.04	0.02	<0.01	<0.04
64	0.08	0.02	<0.01	<0.01	<0.01	<0.03
12	NA[2]	0.05	NA	<0.01	0.01	0.02
66	0.02	0.02	0.01	<0.01	<0.01	<0.01
67	0.07	0.03	0.02	<0.01	0.06	<0.04
68	NE[3]	NE	NE	NE	0.05	--
65 (Control)	0.03	0.02	<0.01	<0.01	0.02	<0.02

The Phytotoxicology Upper Limit of Normal Guideline for Chloride in Rural Moss Bags is 0.03%.

[1] Percent (%) - dry weight

[2] Not available

[3]

TABLE: 11 Fluoride Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1987

Moss Bag Site	Exposure Period April 29 -May 27	May 27 -June 24	June 29 -July 28	July 28 -Aug 31	Aug 31 -Sept 30	MEAN
60	47	32	27	16	47	34
61	64	108	99	54	130	91
62	44	21	26	21	NA[2]	28
63	90	88	90	110	91	94
64	94	53	59	41	49	59
12	59	46	27	21	NA	38
66	34	20	19	13	28	23
67	49	30	89	14	32	43
68	61	16	28	16	NA	30
65 (Control)	30	17	23	15	30	23

The Phytotoxicology Upper Limit of Normal Guideline for Fluoride in Rural Moss Bags is 45 ppm

[1] Parts per million (ppm) - dry weight

[2] Not Available

TABLE: 12 Fluoride Values[1] Found in Moss Bag Monitors Established at 10 Sites in the Vicinity of BCM Limited, Amherstburg

1986

Moss Bag Site	Exposure Period May 27 -July 2	July 2 -July31	July 31 -Sept 3	Sept 3 -Oct 1	Oct 1 -Oct 28	MEAN
60	NA[2]	37	67	38	NA	47
61	NA	130	143	91	37	100
62	NA	44	18	19	NA	27
63	NA	84	75	NA	37	65
64	NA	56	35	71	42	51
12	NA	60	50	41	120	68
66	NA	29	19	15	17	20
67	NA	69	24	50	25	42
68	NE[3]	NE	NE	NE	NA	—
65 (Control)	NA	34	53	40	NA	42

The Phytototoxicology Upper Limit of Normal Guideline for Fluoride in Rural Moss Bags is 45 ppm

[1] Parts per million (ppm) - dry weight

[2] Not available

[3] Moss bag not established until October 1, 1986